Design Considerations for Enhancing Word-Scale Visualizations with Interaction

Pascal Goffin, Wesley Willett, Jean-Daniel Fekete, Petra Isenberg

Design Considerations for Enhancing Word-Scale Visualizations with Interaction

Pascal Goffin* Inria
Wesley Willett† University of Calgary
Jean-Daniel Fekete‡ Inria
Petra Isenberg§ Inria

Abstract

This paper presents a design space for interaction with word-scale visualizations. Most sparklines and word-scale visualizations are static and do not support any interaction. However, when word-scale visualizations are used in digital environments, interaction can enhance their use by allowing various data manipulation and management operations. Our design space covers where, when, and how interaction can be triggered for word-scale visualizations embedded in a text document. It also includes how and when to transition from a view where the text with word-scale visualizations is the focus (document-centric view) to a view in which the visualizations becomes the reading focus (visualization-centric view).

Index Terms: Information visualization, interaction, text visualization, sparklines, glyphs, design space, word-scale visualizations.

1 Introduction

We present design considerations for interaction with *word-scale visualizations*: small data graphics that display information associated with specific words in text (we call these words "entities"). Word-scale visualizations are a generalization of sparklines: "small, intense, simple, word-sized graphic with typographic resolution" [7]. In contrast, word-scale visualizations are open to various visual encodings and a range of scales, including sizes larger than a word, but smaller than a sentence or paragraph [4].

Most past examples of sparklines and word-scale visualizations have been static. However, word-scale visualizations can be used in digital environments where interaction is possible, allowing for various manipulations. There are multitudes of ways to interact with word-scale visualizations; Section 3 categorizes and organizes interactions in a design space and provides design guidance. We then discuss which word-scale visualizations or entities are affected by a given interaction and also how to decide when visualizations should be enlarged or enhanced to support deeper exploration. Further, we discuss approaches for adding new visualizations on top of document-centric views and how one can transition from document-centric views to visualization-centric views.

2 Related Work

Our work relates closely to Bret Victor's "Explorable Explanations" [8], where he promotes the active reader, reactive documents, and the addition of contextual information to given texts. In reactive documents the reader can influence the rendition of embedded statistics. For example, when presenting a document showing the income tax (e. g., 19%) and the total tax revenue of a country (e. g. 36.5% of GDP), dragging the mouse left or right over the income tax text would recalculate and update the total tax revenue displayed. Victor also describes how interactions could be used to elicit additional contextual information from within documents; for example, hovering over a word while pressing a key can trigger a search on Wikipedia and show results in a box over the text.

Similar to Victor's approach, Fluid Documents [3] include interactions on words or word sequences in a document. The authors differentiate between primary information in the text and supporting information like references, derivation of formulas, and descriptions of technical terms. They add this supporting information as graphical annotations to the text. Hovering over a marked phrase causes the annotation to grow in size to improve readability. The text is reflowed to provide space for the growing annotation.

Articles proposing interaction on word-sized data graphics are scarce. One example by Beck et al. [1] uses sparklines in source code; in their tool, hovering over the sparkline results in the visualization being enlarged and shown with more detail in a tool tip.

Perin et al.'s interactive horizon-graph [6] is designed to be very compact and implements several interaction techniques such as baseline panning and zoom. Baseline panning allows for interactively adjusting the horizon-graph's baseline along the y-axis while value zooming specifies the zoom factor. Both are triggered using a continuous dragging interaction occurring over the visualization.

Finally, our work relates to the visualization literature on interaction design spaces, in particular Heer and Shneidermann's [5] twelve task types and Yi et al.'s [9] seven general categories of interaction intents. In contrast to our design space, however, these articles focus only on interactions in visualization-centric views.

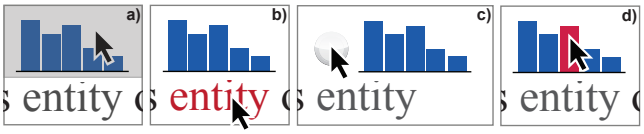

Figure 1: Interactions can take place directly with the entire visualization (a), the related text entity (b), connected GUI controls like buttons (c), or with individual marks in the visualization itself (d).

3 Interacting with Word-Scale Visualizations

In this section, we discuss where and when to trigger interactions with word-scale visualizations, which interaction techniques can be used in a document-centric space, and how to transition between a document-centric and a visualization-centric view.

3.1 Where to Capture Interaction

We differentiate interaction with the entities or the word-scale visualization as a single component vs. with the underlying data and its individual marks. Figure 1 shows the main locations that capture interactions affecting word-scale visualizations: a) the area holding the word-scale visualizations, b) the entity, c) a button or other GUI components, and d) individual data marks of the word-scale visualization. We do not further discuss possible interactions with the underlying data marks (Figure 1 d))—other interaction design space discussions have amply covered the topic [5, 9]. Once an interaction area has been defined, one must consider how an interaction will be triggered or what the result of an interaction will be.

*e-mail: pascal.goffin@inria.fr
†e-mail: wj@wjwillett.net
‡e-mail:jean-daniel.fekete@inria.fr
§e-mail: petra.isenberg@inria.fr

3.2 Interaction Intents

We base our interaction intents for the document-centric space on Yi et al.'s [9] seven general categories of interaction: select, explore, reconfigure, encode, abstract/elaborate, filter and connect. All can be applied to the space of document-centric interactions:

The intent to *select* can involve choosing a particular (or multiple) word-scale visualizations for a specific purpose, for example to hide or unhide it by means of a button. The desire to *explore* a word-scale visualization may in particular be a trigger for moving between document-centric and visualization-centric view to see more data in greater detail. However, occasionally a word-scale visualization may provide too much detail (e. g., on a small map) in which the intent to *abstract/elaborate* may involve zooming out. When a reader wants to change the location of the word-scale visualization, the intent is to *reconfigure* by, for example changing from a strong to a weaker context placement [4]. The *encode* intent involves the substitution of a word-scale visualization for another visual representation of the same data (e. g., a bar chart instead of a line chart). When selectively showing visualizations according to their entity type (e. g. persons) then the intent is to *filter* the set of word-scale visualizations in the document. The *connect* intent comes into play when the reader wants to understand the relation between entities, for example by representing metrics for more than one entity in a single word-scale visualization.

3.3 Interaction Techniques

The main interaction techniques that we consider important with word-scale visualizations in a desktop setting are *clicking*, *hovering*, *dragging*, *panning*, and *contextual menus*. *Clicking* is useful to select word-scale visualization or to trigger events in GUI components such as a button that turns word-scale visualizations on or off. Similarly *mouse hover* can be used to highlight or grow a word-scale visualizations to reveal more information as done in Fluid Documents [3]. *Dragging* can also be used to grow a visualization, to zoom in/out in a map visualization, or to trigger specific interactions like in the interactive horizon-graph [6]. *Panning* can be used to change the viewpoint of a visualization like a horizontal scrolling through a timeline to see more of it. *Contextual menus* are particularly useful to present available options such as other data encodings to e. g. switch from a bar chart to a line chart.

3.4 Interaction Scope

Any interaction in the document-centric space can be triggered for a single entity or word-scale visualization, or for multiple entities or word-scale visualizations at the same time. The number of entities or word-scale visualizations affected by an interaction matters in particular when transitioning to a visualization-centric view. If the reader is only interested in detail-on-demand for a single entity, interaction techniques and finding space to fit the information have been addressed by previous work like in Victors's "Explorable Explanations" [8] and Chang et al.'s Fluid Documents [3]. However, the reader may also be interested in interacting with groups of entities and word-scale visualizations, e. g. all dates in an article or all word-scale visualizations of a single paragraph. In the latter case, a contextual menu is appropriate to assist in choosing which entity group or word-scale visualizations are selected.

3.5 From Document-Centric to Visualization-Centric

In many cases, visualizations may need to be enlarged or altered to support more detailed exploration. We discuss three alternative approaches for moving from a document-centric view to a visualization-centric view: 1) *In-place transition*: when the user interacts, the layout and dimensions of the text and the word-scale visualization do not change. This option is useful when the word-scale visualization already has the appropriate size or if the other two strategies are not applicable.

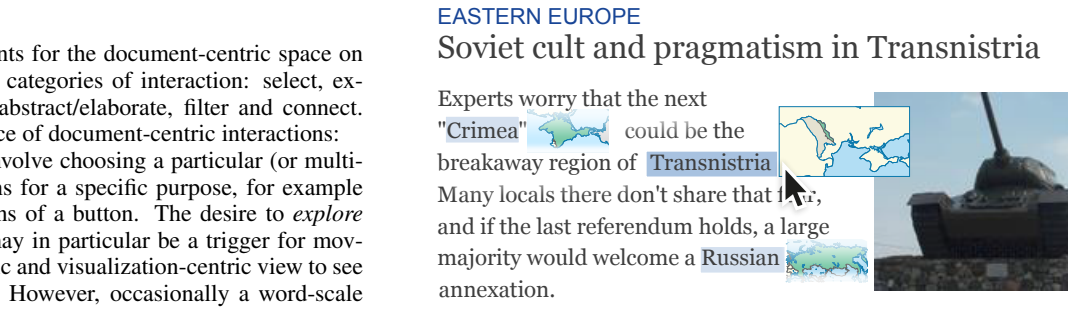

Figure 2: Small maps embedded as word-scale visualizations provide details-on-demand for locations in a news story. Interacting with the entity or map grows the visualization to show more detail. The text stays as it is and the visualization is overlaid over the text.

2) *Growing transition:* the size of the visualization is changed to adapt to the needs of the task (see Figure 2). For example dragging the cursor over an entity allows the user to grow the word-scale visualization according to the distance traveled with the cursor. There are two ways in which the surrounding text can react to such an enlargement: either it can remain static and the visualization will cover and occlude the text as it grows, or the text can reflow around the visualization. In the latter case, the visualization effectively becomes an image in a document and the text flows around the image. 3) *Offsetting transition*: moving the visualization to a place where more space is available—e. g. in the margin or in a separate window—to avoid interfering too much with the readability of the document. In this case, the text does not need to be reflowed.

4 Conclusion and Future Work

We presented a first set of design considerations for interacting with data graphics embedded in text. As future work, we plan to integrate some of the interactions described above into a note-taking environment for historians developed by the European project CENDARI [2] and evaluate these approaches with end users.

Acknowledgements

This work is sponsored by the French Research Organization (grant ANR-11-JS02-003) and supported by the Collaborative European Digital Archive Infrastructure project CENDARI (cendari.eu).

References

[1] F. Beck, F. Hollerich, S. Diehl, and D. Weiskopf. Visual monitoring of numeric variables embedded in source code. In *Proc. Software Visualization (VISSOFT)*, pages 1–4. IEEE, 2013.

[2] N. Boukhelifa, E. Giannisakis, E. Dimara, W. Willett, and J.-D. Fekete. Supporting historical research through user-centered visual analytics. In *Proc. EuroVA*, 2015.

[3] B.-W. Chang, J. Mackinlay, and P. T. Zellweger. Fluidly revealing information in fluid documents. In *Proc. Smart Graphics*, pages 178–181. AAAI, 2000.

[4] P. Goffin, W. Willett, J.-D. Fekete, and P. Isenberg. Exploring the placement and design of word-scale visualizations. *IEEE TVCG*, 20(12):2291–2300, 2014.

[5] J. Heer and B. Shneiderman. Interactive dynamics for visual analysis. *Queue*, 10(2):30, 2012.

[6] C. Perin, F. Vernier, and J.-D. Fekete. Interactive horizon graphs: Improving the compact visualization of multiple time series. In *Proc. CHI*, pages 3217–3226. ACM, 2013.

[7] E. R. Tufte. *Beautiful Evidence*. Graphics Press, Cheshire, CT, 2006.

[8] B. Victor. Explorable explanation, Last read: June 2015. `http://worrydream.com/ExplorableExplanations/`.

[9] J. S. Yi, Y. ah Kang, J. T. Stasko, and J. A. Jacko. Toward a deeper understanding of the role of interaction in information visualization. *IEEE TVCG*, 13(6):1224–1231, 2007.